DETERMINING THE CHARACTERISTICS OF SEAFOOD CONSUMERS AND THEIR PREFERENCES FOR FRESH SEAFOOD: EVIDENCE FORM HOUSEHOLD SCANNER DATA FROM FIVE US MARKETS

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To my mother, father, and sister

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AC Nielsen Homescan data was used in this project to gain insight into the factors that affect a consumer's decision to purchase fresh, over the counter seafood products. It is hypothesized that this decision is based on the consumer's demographic traits, their preferences, and the behavioral attributes of the consumer. The data consist of household-level weekly seafood purchases by UPC over the course of three years for five major market areas in the United States: Miami, Chicago, Houston, Memphis, and New Orleans-Mobile.

Seafood can be argued as separable from other meat products, as studies concerning other forms of meat have left seafood absent form their analysis (Anders and Moeser 2008). Through logistic regression models, using the maximum likelihood estimation approach, the probability of a household purchasing seafood, and the probability of a seafood consuming household purchasing fresh seafood have been analyzed.

Household composition, education, income, age, and region have statistically significant effects on the likelihood of a household purchasing seafood. Additionally,

past purchase behavior such as average weekly seafood expenditure, coupon use, average duration between purchases, number of seafood items purchased, and household characteristics such as region, age of household head, and household composition all have statistically significant effects on the likelihood of a seafood consuming household purchasing fresh, over the counter seafood.

Results from this analysis will serve to help firms create opportunities/dispel myths, aid marketers in associating demographic characteristics with seafood purchase behavior, and gain valuable knowledge concerning the market for fresh, over the counter seafood.

CHAPTER 1
INTRODUCTION

Since the dawn of civilization, populations have strategically positioned themselves near the coast of oceans, seas, and rivers, leading to dependence on the resources of the sea for nutrition, sustenance, and a way to make a living. As a result, seafood products feed the majority of the world's population and in many cases, seafood products are inherent to the survival of particular communities. Therefore, billions of people have a large stake in the production and procurement of seafood. Determining why a consumer chooses to purchase seafood (what drives the choice) has many implications for this vast array of stakeholders involved in seafood procurement and seafood production. And, by extension, careful management of resources from the sea is necessary to provide humans with a valuable and sustainable food source for present and future generations.

At the individual level, seafood products may be sought after because they are considered to be a healthy protein alternative due to the presence of omega 3 fatty acids, which are important for normal metabolism and have been linked to improved immune function (Daly et al. 1992). Perception alone does not drive a consumer choice, therefore this project seeks to identify what other factors drive a consumer to choose to purchase seafood, and moreover, what factors drive a consumer to choose to purchase fresh seafood. It is believed that the type of consumer (i.e. their demographics) plays a large role in consumer choices (Nauman et al. 1995), so these demographic aspects will be investigated thoroughly.

Despite forecasts of declining worldwide seafood supply, the sale and production of seafood products has become increasingly competitive (Wessels 2002). Moreover, retail trends in the seafood market over the course of 2013 show a marked increase in the volume of fresh seafood sales, as well as the dollar value of fresh seafood sales (Frey 2014), which have many implications for commercial fishers, seafood marketers, and others throughout the supply chain of seafood production. Additionally, investigation into the consumer market for fresh, over the counter seafood products has been scarcely conducted. This analysis will seek to fill in this aforementioned gap in the previous literature.

Information on consumer demand for seafood products has primarily been obtained from household surveys. While the use of 'stated preference' data (i.e., obtained from surveys) is critically important for determining potential demand for new products, 'revealed preference' data (i.e., obtained from past behavior) is more credible for assessing tradeoffs between existing products and product attributes because it is not a function of respondents' memories. The use of electronic scanners in grocery stores provides UPC-level data on prices and quantities sold, but the data sets are expensive and few grants provide sufficient funds for acquisition (especially over a long time horizon). As a result, published studies using scanner data have examined a very small set of product types (i.e., organic eggs, fluid milk, and certified organic salmon and Pollock). Most importantly, scanner data from grocers does not contain demographic information on the purchaser, which severely limits the extent to which results can be used for effective marketing campaigns. In order to market seafood products efficiently and effectively, information on purchasers in a product's target market (i.e. what characteristics do the consumers of a particular product, in this case, seafood products, exhibit) is needed in order to determine the most suitable marketing strategy.

Electronic scanner sin grocery stores provide one type of behavioral data on consumer purchases. Electronic scanners, are however, being used within households to track all of the products that consumers buy. These data, household-level scanner data, are panel data sets generated from a sample of survey participants that scan universal product codes (UPCs) of all products that were purchased on each trip that they make to the grocery store over a period of time (i.e. two weeks to three months). Each of the participating households provide their demographic information, and record their purchases in exchange for compensation; these companies (i.e. AC Nielsen) then use this data to generate market reports (i.e. projected sales) that they sell to producers and suppliers. this aids in associating seafood consumption preferences with demographic characteristics and in modeling consumer demand for seafood products. Such data are rich for the examination of actual purchase behavior, including the choices and tradeoffs that consumers faced, including for seafood products.

Goals and Objectives

This project seeks to add to the published literature pertaining to using scanner data at the household level to make inferences on the likelihood of purchasing seafood and the likelihood of purchasing fresh, over the counter seafood. As stated previously, investigation into the retail-level market for seafood products has been scarcely conducted and determining what drives the choice of a consumer when they decide to purchase fresh, over the counter seafood, in particular, has rarely been examined. This analysis will add to the literature by first determining the characteristics of households that buy seafood (and fresh seafood), and comparing that to the general population.

This analysis will add to the literature by first determining the characteristics of households that buy seafood (and fresh seafood) and comparing that to the general population. This will be accomplished using household-level scanner data that were purchased from the Nielsen Corporation (formerly known as ACNielsen or AC Nielsen), which is a global market research firm; this data is known as “Homescan” data. The characteristics of buyers of different types of products will also be compared to the general population in each of five market areas: Chicago, Houston, New Orleans-Mobile, Memphis and Miami.

Using these same data, investigation of the factors that influence a consumer’s choice to purchase seafood in general. Since households that purchased seafood have product information associated with their demographic characteristics (whereas households in the data set who did not purchase seafood only have demographic information), more information is available on these “seafood purchasing” households. Therefore, we first identify the household characteristics that affect the likelihood of purchasing seafood in general, and then identify the household characteristics and behaviors that drive the choice between purchasing fresh seafood sold at counters and purchasing frozen seafood in the freezer section of grocery store. In addition, the magnitude of these factors is determined and compared.

The analysis in general seeks to explain how consumers of seafood are inherently different from consumers who do not consume seafood, and that seafood eaters who consume fresh, over the counter seafood products are inherently different from seafood eaters who do not purchase fresh, over the counter seafood products. It is hypothesized that these differences exist due to demographic characteristics, as well as behavioral characteristics and preferences of the purchaser. Predicting the likelihood of a household purchasing fresh, over the counter seafood as explained by other variables will aid in understanding and describing this virtually un-researched group of consumers. In summary, this analysis models the likelihood of a household purchasing seafood; and from there, models the likelihood of a seafood purchasing household purchasing fresh, over the counter seafood. Questions that will be addressed include but are not limited to: Do purchasers of fresh seafood purchase seafood more frequently? Does coupon use affect the likelihood of a household purchasing fresh, over the counter seafood products? What are the key demographic traits associated with purchasers of fresh seafood? And are there any regional differences in the consumption of fresh, over the counter seafood?

Results from this analysis will serve to help marketers gain insight into the seafood market across these five major market areas and aid them in decisions and strategy. In addition, the analysis results can be used to help firms create opportunities or dispel myths when it comes the nature of the fresh, over the counter seafood product market.

Overview of Study

Following this introduction, the next chapter, Chapter 2, contains a review of relevant studies that have used scanner data, have assumed seafood products are separable from other protein products with respect to consumer demand, and have estimated probability-based models. Chapter 3 provides a theoretical background on utility maximization and the need for linear probability models. Chapter 4 contains a description of the data used in the analysis, including information on overall seafood expenditures, fresh seafood product expenditures, summary statistics of the variables used in the analysis, and a city by city comparison of the households in the sample and the households in the population. In Chapter 5, an econometric model is specified to test for factors that explain households that purchase seafood and, of those, households that purchase fresh, over the counter seafood. The empirical results chapter (Chapter 6) includes descriptions of statistically significant odds ratio estimates and their interpretations. In the final chapter (Chapter 7), the results are summarized and the implications of the empirical results are discussed including ways to extend the analysis and recommendations for marketers and firms that are involved in the production and sale of seafood products, and fresh seafood products in particular.

CHAPTER 2
LITERATURE REVIEW

The literature review is organized into four subsections. First, studies using point-of-sale (retail-level) scanner data will be reviewed to show what types of questions can be answered with these data. Second, studies using household-level scanner data are summarized to better understand what type of distinct information can be examined. Since this analysis only contains information on seafood products, how other researchers have addressed the separability of seafood products from other meat products is reviewed as well. Lastly, studies that have used (and estimated) probability based models and approaches to examine the factors that affect whether or not variables are correlated with a decision or outcome are reviewed.

Retail-level Scanner Data and Food Products

Retail-level scanner data has been useful in trying to explain characteristics of a market for seafood products. Retail scanner data has been used to investigate the price impacts of promotional activities, the Gulf oil spill, major holidays, and product labeling such as “wild” or “imported” (Larkin and Gold 2012). The authors of this article used a hedonic shadow pricing model to determine implicit price attributes of seafood products and found that promotional activities, product labeling, product form, and time events such as Christmas, Lent, and the 2010 Gulf Deepwater Horizon Oil Spill all had statistically significant effects on the price of seafood products. Roheim, Gardiner, and Asche 2007 also used retail-level scanner data to conduct a hedonic shadow pricing model. This aforementioned study was performed in the United Kingdom and found that species was relevant across the supply chain, but that brand is only relevant at the consumer level. In addition to this, the study found that breaded and battered seafood products, although technically value-added, have a lower final price value when compared to smoked, fresh, or regular frozen fish. This is due to the idea that the breaded/battered product originated from a lower quality in the beginning and is not of “high quality” or of “natural” origin.

Retail-level scanner data has also been used to calculate own-price, cross-price, and expenditure elasticities for different species of fish and shellfish, as well as provide information into the seasonality of seafood demand (Singh and Dey 2012). Singh and Dey found that all species of un-breaded seafood (except flounder and lobster) had demand that was statistically significantly affected by seasonality, that tilapia has a high overall degree of substitutability (measured by compensated cross price elasticity), and that the short run demand for shrimp and lobster is approximately unitary own-price elastic and expenditure elastic, which indicates the luxurious nature of these products in the U.S.

Also in 2012, Chidmi, Hanson, and Nguyen used retail scanner data to calculate the substitutability and complementarity between seafood products by regressing expenditures on weekly earnings and by regressing price on weekly earnings, CPI, PPI, gas prices, and the three month commercial paper rate. It was found that demand for catfish, crawfish, clams, and salmon products is elastic, suggesting that consumers are more sensitive to price changes for these products and that demand for shrimp and tilapia (which tend to be mostly imported) is price inelastic.

Although retail-level scanner data provides information about the type of product that is purchased, it is limited in that the demographic characteristics of the product purchaser remain unknown.

Household-level Scanner Data and Food Products

The groundwork for using scanner data to model seafood demand at the household level was initiated by Cheng and Capps in 1988; these authors used at home scanner data to explain the variation of seafood expenditures with respect to a suite of demographic variables including income, occupation, age, household size, race, and region. Emphasis for the analysis was placed on expenditure-income (Engel) relationships. It was found that household size and own-price elasticity are the most important factors in determining seafood expenditures.

Additionally, household-level scanner data has also been used to explain the demographic characteristics of seafood consumers by dividing people into separate groups based on race, income, and region and testing for statistically significant differences in seafood preferences amongst the groups (Davis, Yen, and Lin 2007). High income households were found to be less responsive to price changes (exhibiting a more inelastic demand).

Household level scanner data has been used to make inferences on the market for organic food products (one of the fastest growing food sectors in the United States) as well. Zhang et al. in 2009 utilized household-level scanner data to investigate organic price premiums paid for fresh tomatoes and apples (two of the top organic produce sellers in the U.S.). Age, annual household income, and the presence of children were found to statistically significantly affect the price premiums paid for organic tomatoes, and household size, annual household income, age, and region were found to statistically significantly affect the price premiums paid for organic apples. Additionally, Dettman and Dimitri in 2009 used AC Nielsen Homescan data to comprise a demographic profile of organic vegetable consumers. These researchers found that household heads with a higher level of educational attainment were statistically significantly more likely to purchase organic vegetables than were less educated households, and also found that African American households and older households were statistically significantly less likely to purchase organic vegetables.

Separability of Seafood Products from Other Meat Products

Although scanner data can be used to make inferences on the consumer market for all types of food (fruits, vegetables, meat, etc.), it can be argued that meat comprises a separate category when compared to all other types of food bought at grocery stores due to the fact that it is considered a staple of main course meals and is high in protein. Additionally, it can be argued further that within this meat/protein category of food, seafood products comprise their own entity when compared to other types of meat. Using weak separability testing, it was found that when fish and other meat products were disaggregated into fresh and processed products, fish can be modeled separate from other forms of meat products (Salvanes and DeVoretz 1997).

Additionally, studies concerning demand for meat have left fish and seafood absent from the analysis such as Choi and Sosin in 1990. Choi and Sosin analyzed structural changes in the demand for meat products (seafood products were not included) and found that structural change occurred in the 1970s and provides measures of the time pattern of demand shifts. Also, Anders and Moeser in 2008 used household-level scanner data to make inferences on demand for meat in Canada (this included beef, poultry, pork, turkey, and lamb; however seafood was left out). The absence of seafood products from the aforementioned analyses concerning meat points to the separability of seafood products for the analysis that will follow.

Choice Modeling of Food Purchases

Smith et al. (2006) utilized the 2006 Nielsen Homescan panel to investigate the probability of a household belonging to a certain organic produce consumer group (devoted, casual, or nonuser). These researchers used an ordered logit model to quantify the impacts of socio-demographic factors on the probability of a household belonging to one of the three previously mentioned organic purchaser groups and found that ethnicity, region of the country, the presence of children, education of the household head, and age of the household head are all statistically significant predictors when modeling the probability of a household being a devoted organic purchaser, a casual organic purchaser, or non-purchaser of organic produce.

Roheim and Johnston (2005) used a rank-ordered logit choice model to explain preferences for eco-labeled fresh, over the counter seafood. The primary emphasis was the potential tradeoff between taste and the presence of an eco-label, given that multiple fresh, non-processed seafood products are available. These researchers found that consumers are unwilling to choose a less-favored species (i.e., to sacrifice taste) based solely on the presence of an eco-label.

Given the availability of demographic variables that are available with household-level scanner data, linking consumer choices with demographics is possible. For example, Martinez et al. in 2007 found that race, education, region of the county, household size, age of household head, and household composition were all statistically significant in predicting the probability of a household purchasing “branded” beef. These researchers used a logistic regression, conducted their analysis at the household level, and utilized “projection factors” to properly weight each household in the sample.

Much like purchasing “branded” beef or “non-branded” beef, a consumer must make a similar choice when it comes to purchasing and consuming fresh, over the counter seafood versus purchasing seafood products in the freezer section of the grocery store. A consumer’s choice is based on experience, perception, preference, and demographic factors (Nauman et al. 1995). Nauman et al. used a consumer survey to gather information regarding the consumer choice to purchase fresh hybrid striped bass, trout, and salmon. Through logistic regression analysis, it was found that knowledge that the product was farm raised along with the perception that seafood is a healthy alternative to other and statistically significantly affect the consumer decision to purchase fresh seafood.

For the analyses that follow, experience and perception manifest themselves in the behavior of the consumer and work with a consumer’s preferences and demographic traits to drive the choice between purchasing fresh seafood sold at counters and purchasing frozen seafood in the freezer section of the grocery store.

CHAPTER 3
THEORETICAL BACKGROUND

In economics, it is assumed that consumers make choices to maximize their utility. As such, there is a continuous array of utility "values" that a consumer can derive from making choices and that utility is correlated with both observable and unobservable factors. For example, consider that an individual derives utility from eating seafood, which can be represented as:

$$U^S{}_i = B^S X_i + \varepsilon^S{}_i \tag{3-1}$$

Where U^s is the utility of consuming seafood products, X are the individual's characteristics (such as age, education, income, number of children, city, etc.), B is a vector of associated parameters (i.e., marginal effects of each variable on utility from seafood), and ε is individual i's unobserved tastes for seafood. On the other hand, certain other individuals may derive utility from avoiding seafood:

$$U^{NS}{}_i = B^{NS} X_i + \varepsilon^{NS}{}_i \tag{3-2}$$

Where here, U^{NS} is the utility derived from avoiding seafood products, and ε is an individual's unobserved tastes for avoiding seafood products. If the individual makes their decision based on the option yielding the highest utility, as assumed by economic theory, that (s)he will buy seafood if and only if $U^S{}_i > U^{NS}{}_i$, which can be expressed as if:

$$B^S X_i + \varepsilon^S{}_i > B^{NS} X_i + \varepsilon^{NS}{}_i \tag{3-3}$$

Or, by rearranging to isolate the error terms on the left hand side, as:

$$\varepsilon^S{}_i - \varepsilon^{NS}{}_i > B^{NS} X_i - B^S X_i \tag{3-4}$$

Finally, representing the unobserved tastes:

$$\varepsilon_i > B^{NS} X_i - B^S X_i \tag{3-5}$$

In other words, this latter expression (generically: $\varepsilon_i > - BX_i$) is modeling a consumer that chooses to buy seafood. If we consider this problem as a choice, then we can define a binary variable as follows: $Y_i = 1$ if and only if $\varepsilon_i > - BX_i$ and $Y_i = 0$ if and only if $\varepsilon_i < - BX_i$.

Considering that the dependent variable in question (Y_i) is a choice that has a binary distribution (yes, the household purchased seafood; or no they did not), and this distribution is bounded by zero and one, it would be possible to use a linear probability model in order to predict the probability of that dependent variable occurring. Coupling this fact with utility maximization theory, the following equation can be obtained:

$$Pr(Y=1) = Pr(U^S > U^{NS}) \tag{3-6}$$

Where Y is a binary dependent variable (the choice to purchase seafood, U^S is the utility of purchasing seafood, and U^{NS} is the utility of not purchasing seafood. Predicting the probability that Y occurs is the same as predicting the probability that the utility of purchasing seafood is greater than the utility of not purchasing seafood. Similar to Equation 3-6, the following can be assumed:

$$Pr(Y=0) = Pr(U^{NS} > U^S) \tag{3-7}$$

Equation 3-7 says that predicting the probability that Y does not occur is the same as predicting the probability that the utility of not purchasing seafood is greater than the utility of purchasing seafood.

Linear probability models can be estimated with the OLS method, however in using the OLS method to estimate a linear probability model, the error term, by definition, must be heteroskedastic. Heteroskedasicity means that the error terms in an econometric model are not constant and random, that is, the error term varies from observation to observation in some sort of predictable fashion (i.e. the error terms are dependent upon the observations in some way). This problem can lead to biased standard error estimates of explanatory variables and in turn lead to invalid conclusions. To illustrate how using the OLS method in a linear probability model leads to heteroskedasicity, the following simple OLS linear probability model will be examined:

$$Y=Fresh=\beta x + \varepsilon \quad \text{where Fresh} \in (0,1) \tag{3-8}$$

Where Y is a binary dependent variable equaling 1 if a consumer purchased fresh seafood products and equaling 0 if they did not, β is a vector of unobserved regression parameters, x is a vector of explanatory variables, and ε is an error term. By assumption, the error term in Equation 3-3 must be heteroskedastic because Y can only take on two values (zero and one). Therefore, given x, ε can only take on two values as well. Using algebraic manipulation of Equation 3-8:

$$\varepsilon= Y-\beta x \tag{3-9}$$

When Y takes on the value of one, then

$$\varepsilon= 1-\beta x \tag{3-10}$$

Which given that E(ε)=0, occurs with probability βx. Similarly when Y takes on the value of zero:

$$\varepsilon= -\beta x \tag{3-11}$$

Which given that E(ε)=0, occurs with probability 1- βx. The error term can only take on these two values in a linear probability model with a binary dependent variable. Therefore:

$$Var(\varepsilon)=E(\varepsilon^2)=(1-\beta x)^2\beta x + (-\beta x)^2(1-\beta x) \tag{3-12}$$

$$Var(\varepsilon)= (1 - \beta x) \cdot [(1 - \beta x)\, \beta x + (\beta x)^2] \tag{3-13}$$

$$Var(\varepsilon) = (1 - \beta x) \cdot [\beta x - \beta^2 x^2 + \beta^2 x^2] \quad (3\text{-}14)$$

$$Var(\varepsilon) = (1 - \beta x) \cdot \beta x \quad (3\text{-}15)$$

$$Var(\varepsilon) = E(y|x) \cdot E((1\text{-}y)|x) \quad (3\text{-}16)$$

Equation 3-16 shows the variance of the error term is not constant, and is heteroskedastic. The variance of the error term will be higher when the values of x are such that the predicted probability of the outcome is close to 0.5, and lowest when the predicted probability of the outcome is close to 0 or 1. Considering that it is necessary that the model does not exhibit heteroskedasicity, a different method from OLS must be employed. Additionally, some predictions using the OLS method will fall outside these bounds of zero and one (which are the only two possible outcomes of this dependent variable). To keep these predictions inside these zero and one bounds, a generalized linear model must be used, and therefore one must choose between a probit or a logit link function (i.e. the distribution of ε).

The generalized linear model uses the maximum likelihood estimation approach to calculate parameter estimates, and the predicted probability of the dependent variable occurring is always greater than or equal to zero and less than or equal to one. This is the type of estimation that is preferred for the econometric model specified in this analysis. The probit link function assumes that the error terms in the model take the form of the standard normal distribution, whereas the logit link function assumes that the error terms in the model take the form of a logistic distribution. The response curves for logit and probit are very similar, and for a large number of observations, the results from each method will be very similar as well. Hahn and Soyer (2007) state that the conventional wisdom in choosing between the probit and logit link is that “in most cases, the choice of the link function is largely a matter of taste." Greene (1997) concludes his discussion of the issue with "in most applications, it seems to not make much difference." And Gill (2001), perhaps most succinctly, states that "they provide identical substantive conclusions." Similar advice concerning the choice to use the probit or logit link is found elsewhere as well (e.g. Long 1997, Davidson and MacKinnon 1993, Hardin and Hilbe 2001).

Referring back to Equation 3-8, βx is the structural component, and ε is the random component. Continuing from this, the most appropriate link function (either logit or probit) must be specified. The predicted mean, μ, will not necessarily be mathematically the same as the response distribution's canonical location parameter; so the link function that does equate them is known as the canonical link function. The advantage of using the canonical link function is that a minimal sufficient statistic for β exists. The canonical link for the binomial distribution is the logit link. Therefore, the analysis that follows will use the logit link function and a logistic regression model will be specified. Past literature that used Homescan data to model the likelihood of a binary dependent variable occurring utilized the logit method as well (Martinez et al. 2007, Nauman et al. 1995). And the logit method is modeling the logged odds of a dependent variable occurring; this provides ease of interpretation since the independent variable effects are interpretable as odds ratios.

As further evidence, a study was performed to compare OLS and logistic regression in terms of their underlying assumptions as well as the results obtained on common data sets (Pullman and Leitner 2003). In both methods, the dependent variable had a binary distribution of whether a student dropped out of school or if they attended a private college. These researchers found that the predicted values using OLS regression and using logistic regression were highly correlated, and they concluded that both models can be used to test relationships with a binary criterion. However, the researchers specified that logistic regression is superior to OLS at predicting the probability of a binary dependent variable occurring, and should be the model of choice for that application because the logistic regression yielded more accurate predictions of dependent variable probabilities as measured by the average squared differences between the observed and predicted probabilities. Based on this theoretical analysis, and that the dependent variable in question for this analysis is a binary response variable, the maximum likelihood estimation approach will be utilized with a logit link function to facilitate the interpretation of the coefficient estimates.

CHAPTER 4
DATA

The data used in this analysis were obtained from the Nielsen Corporation (formerly AC Nielsen), a global marketing firm. One of their products (the Homescan data) includes information on retail purchases made by panel members over time Homescan Panel. Each time that a participating household purchases groceries (including seafood products), they scan all of their purchases from that particular trip to the grocery store and enter quantities and purchase price from the receipts in their home. These data collectively comprise a national panel dataset of purchases by representative households. The households in The Nielsen Corporation database (i.e. Homescan data) are recruited to represent a stratified random sample, selected on geographic, as well as demographic targets. This method ensures that the sample matches the demographic profile of consumers according to the United States Census. The primary sampling unit is the household and AC Nielsen specifies that there was no intentional clustering. All of the summary statistics and all empirical analysis in this project utilize the household-level projection factors, which are sample weights calculated for each household in the panel to reflect the demographic distribution of the US population.

The Homescan data used in this project encompasses seven AC Nielsen seafood modules: 2683 (un-breaded frozen fish), 2682 (un-breaded frozen shrimp), 2643 (breaded frozen shrimp), 2607 (breaded frozen fish), 2679 (breaded frozen shellfish), 2686 (un-breaded frozen shellfish), and 0750 (RFCD fish shellfish; which is the “fresh” seafood sold at counters). Module 0750 is one focus of this project. This particular module represents all seafood products sold over the counter at grocery stores; however the limitation of this module is that the species of the product is not known; It is only known that it is a “fresh, over the counter” seafood purchase. Therefore, species information is only available for the frozen seafood product purchases that are not sold over the counter.

The data were obtained for five major market areas included in the AC Nielsen Homescan panel: Miami, Chicago, Houston, Memphis, and New Orleans-Mobile, and over a three year period beginning on December 30, 2007 and ending on December 25, 2010. The data consist of weekly purchases by UPC and household and corresponding household information.

Each participating household is represented by a Panelist ID number and several demographic characteristics at the household level such as income, presence of children, household size, household composition, and market area are provided. In addition, detailed information is available on each the head of each household including age, education, race, occupation and employment status.

The raw data were provided in separate sets of data: one data set had panelist IDs associated with purchase and product information (by module), and one data set had panelist IDs associated with the demographic information. Therefore, the first step was to merge the two data sets and have a single Panelist ID associated with each product purchased, as well as associated with the demographic information of the panelist.

The merge revealed that some seafood purchases were not associated with a valid panelist ID, and that some panelist ID’s had demographic information but were not included in the data set on the seafood purchases. In all, there are 2,557 different households in the data set that have demographic information associated with panelist IDs, and 1,961 households out of the 2,557 households with demographic information purchased seafood at least once over the three year duration that the data encompasses.

The remainder of this chapter includes detailed discussions of the data on the following four topics: (1) statistics on fresh seafood expenditures by panelists, (2) a comparison of seafood eating households to those that did not purchase seafood, (3) an examination of past seafood purchases by species and product form, and (4) a comparison of panelists by market area and compared to the most recent U.S. Census. This information is intended to help identify factors that are hypothesized to be correlated with seafood consumption and, of those that have purchased seafood, those households that buy fresh seafood.

Fresh Seafood Expenditures

The first step in analyzing purchases of fresh, over the counter seafood products was to investigate the expenditures on fresh, over the counter seafood as a proportion of the expenditures on seafood as a whole (Table 4-1). All monetary figures reported in Table 4-1 and from this point forward are adjusted with the seasonally adjusted consumer price index and expressed in “real” terms, using December 2010 dollars. As one can infer, the share of fresh product expenditures as a fraction of total seafood expenditures is slightly increasing over the three years that the data encompasses. In 2008, fresh, over the counter seafood products represented 20.1% of total expenditures on seafood by panelists in the data set. This figure increases to 25.4% in 2009, and then to 26.5% in 2010. This trend of more consumer dollars being allocated toward fresh seafood products when compared to other seafood products has many implications for commercial fishers, seafood distributors, and grocery stores throughout the supply chain. However, considering that this trend is only slight at best and was consistent cross all market areas, all of the empirical analysis was taken at the household level (as done by Martinez in 2007) and the three years of purchase data were pooled.

Demographic Comparison of Seafood Eaters and Non-Seafood Eaters

A demographic profile of the panel as whole, as well as a comparison between panelists that purchased seafood and panelists that did not purchase seafood is displayed in Table 4-2. All of the figures represented in Table 4-2 utilize AC Nielsen household projection factors. Some interesting results were uncovered when the demographic summary statistics were examined. There was a very high proportion of households in which the head was over 65 years old. 40% of the seafood eating, and 50% of the non-seafood eating households in the panel had a household head that was 65 years or older. In terms of occupation, nearly the entire sample (95%) was comprised of “retired/unemployed” individuals. The only other response for this occupation variable was “laborer,” so it is likely that this study will not be able to test for a correlation between occupation and probability of eating (buying) seafood. Also, the panel shows a lack of racial diversity due to the high proportion of white/Caucasian households (73% of the panel, 72% of seafood eating households, and 75% of non-seafood eating households) when compared to other races. Annual household income seems to be fairly evenly spread across the categories. This variable was coded as an ordinal variable and the categories were as follows: under $5,000, $5,000-$7,999, $8,000-$9,999, $10,000-$11,999, $12,000-$14,999, $15,000-$19,999, $20,000-$24,999, $25,000-$29,999, $30,000-$34,999, $35,000-$39,999, $40,000-$44,999,

$45,000-$49,999, $50,000-$59,999, $60,000-$69,999, $70,000-$99,999, and $100,000 & over. The categories for income were truncated (Table 4-2) to facilitate comparison, however, to provide a continuous representation of this income variable, the midpoint of the range of each income category was calculated (except for the highest income, which was simply assumed to equal the lower bound of the category). The mean income midpoint for the entire panel is $40,960 annually, but the mean income midpoint for seafood eating households is $42,150 versus just $36,820 for non-seafood eating households. Finally, the income distribution of the panel and the corresponding midpoint for each income category is presented in Table 4-3.

Married households represent 37% of the panel like for income, seafood-eating households in the panel have a higher share of married households compared to non-seafood eating households (40% versus 25%). Delving more into household composition, a larger share of seafood eating households have children in the household (22%) than do the non-seafood eating households (17%). There is also a very high rate of educational attainment amongst the panel, with 94% of the household heads completing high school, 55% completing some form of college, and 24% completing college. Additionally, when examining household size, it was discovered that seafood eating households had a higher average household size (2.34) than did non seafood eating households (2.04). Because of these aforementioned findings, especially the noticeable oddities when examining the high proportion of households in which the head is over 65 years old, the high proportion of white households, and the high proportion of married households; the demographic profile of the panelists in the data set for each market area was compared to the United States Census figures from 2010 in the final section of this chapter.

Past Purchase Behavior and Species/Product Form Preferences

Along with demographics of the household, it is hypothesized that the choice to purchase fresh, over the counter seafood is also driven by past purchase behavior as well as species/product form preferences of the consumer. The summary statistics for these variables are displayed in Table 4-4. An important thing to note about this table is that it specifically represents households in the panel that purchased seafood (the 596 households that did not purchase seafood are not represented in this table because they do not have purchases associated with them). The variable "FRESH" is a binary response variable and represents the households that made at least one fresh, over the counter seafood purchase over the three year period. The mean of this variable is 0.33, which indicates that one third of all seafood purchasing households purchased fresh, over the counter seafood products. The average duration between purchases is 11.27 weeks, and the average number of seafood items purchased made by a household over the three year span is 13.18. The average weekly expenditure (mean of $14.66) for a household was calculated by taking the average of all of the weekly seafood expenditures of that household, but only in weeks in which seafood was purchased (to prevent the zero values from skewing the "average weekly expenditure" variable toward zero).

Whether a household used coupons or not was examined as well. 20% of the seafood consuming households utilized a coupon for their seafood purchases at least once over the three year period. The next set of variables reflect the share of a household's expenditures on frozen seafood dedicated to the following species: shrimp, tilapia, salmon, catfish, and cod. Each of these “percent share” variables have a maximum of 1.00, which indicates that there are households that dedicate their entire frozen seafood budget toward one particular species. These five species were chosen is because they represent the species that households in the data set spent the greatest dollar amount (on average) of their seafood budget on (Table 4-5). When considering all types of seafood (fresh and frozen), the average household in the data set allocates 31.83% of their seafood budget (in dollars) to frozen shrimp, 8.78% of their seafood budget to frozen tilapia, 7.89% of their seafood budget to frozen salmon, 1.76% to frozen catfish, 1.70% to frozen cod, and 18.37% to fresh over the counter seafood products. The remaining 29.68% of the average household’s seafood budget is allocated to other species of frozen seafood (Figure 4-1).

There are also “percent share” variables pertaining to process form. These variables reflect the share of a household’s expenditures on seafood as a whole dedicated to the following: frozen filleted purchases, breaded process form purchases, and generic (store brand purchases). These figures were evaluated to gain more insight to household preferences for certain process forms and as well as household preferences for store brand seafood products (which tend to be more affordable than branded products). These aforementioned variables all had maximums equal to 1 (100%) as well, indicating that some households dedicate their entire seafood budget to a particular process form of seafood.

Comparison of Census with Panelists by Market Area

The 2010 National Census was utilized for this comparison. All Census figures were analyzed at the city level and were obtained from the Bureau of Labor Statistics. The Homescan panelists in each city were compared their corresponding Census figures for that city (Tables 4-6 through 4-10) and were weighted with each household's corresponding AC Nielsen projection factor. The process for this Census comparison operated as follows: first, the Census figures for each market area were collected and compared to the Homescan panelists in that particular market area. From there, the Census figures were compared to seafood eaters from the matching market area, and subsequently compared to consumers of fresh, over the counter seafood products from the matching market area. Some consistent patterns exist across all five of the market areas. For one, the proportion of household heads in the panel that are 65 years and older is much greater than as reported by the Census. However when comparing seafood eaters in each market area to all of the panelists from its matching market area, the proportion of household heads over 65 years of age is less for seafood eaters, and even less for purchasers of fresh, over the counter seafood products. Even though the proportion of household heads over 65 years old is less for consumers of fresh seafood than it is for the entire panel, the figure is still much greater than the Census reported figures in all five market areas.

Additionally, all of the market areas except for New Orleans-Mobile exhibit a lower proportion of households with children when compared to the Census. For seafood eaters, the proportion of households with children tends to be larger for each market when compared to the all of the panelists in the matching market area. Furthermore, except for New Orleans-Mobile, the proportion of households with children is even larger for households that consume fresh, over the counter seafood products when compared to seafood eaters as a whole from the matching market area, and also when compared to the corresponding Census figures for that particular city. Continuing with household composition, married households tend to be more prevalent amongst the panel when compared to the corresponding Census figures (except for Houston). The proportion of married households is larger when examining seafood consuming households, and even larger when examining households that consume fresh, over the counter seafood products in all five market areas over the time horizon examined.

For education, there is a higher level of college completion reflected by the 2010 Census when compared to the panel. For consumers of fresh, over the counter seafood, the proportion of households in the panel that completed college is even larger than the figures that represent the entire panel (except for Houston), perhaps indicating that households who consume fresh, over the counter seafood tend to be more educated.

Household sizes in the panel as a whole are smaller, on average, than as reported by the Census. However, the mean household size for seafood consuming households is larger than the entire panel in each market area, and the mean household size is even larger than that when examining consumers of fresh, over the counter seafood in each market area as well. Along with the finding that the mean household sizes of fresh seafood consuming households were larger than household sizes in the panel as a whole, the mean household sizes were also larger than the Census reported figures for every market area except for Miami. This could imply a positive relationship between household size and the likelihood of purchasing fresh, over the counter seafood products.

Perhaps most striking is the lack of racial diversity amongst the panel when compared to the Census figures. There is a much lower proportion of minorities in each of the market areas in the panel than as reported by the corresponding 2010 US Census figures for each of the cities. However, there is not much of a discernable trend for racial composition as seafood consuming households and fresh seafood consuming households are compared to the panel as a whole. As it pertains to median annual household income, some of the market areas reported a higher median annual income in the Census when compared to panelists in the market area (Memphis, Chicago, Houston, New Orleans-Mobile) and Miami panelists were discovered to have a higher median annual household income than as reported by the 2010 Census. Additionally, fresh seafood consuming households in Chicago, Houston, Memphis, and Miami had a higher median annual household income when compared to all of the panelists in each of their corresponding market areas.

Summarizing, although AC Nielsen projection factors were used in this census comparison to properly weight each household, households in the panel still exhibit some key differences when compared to the population, especially as it concerns age, race, and household composition. The AC Nielsen household projection factors will be used in the models as well to properly weight each household and help correct for any disparities between the sample and the population. When using data from a sample, the sum of weights in a particular subgroup of the sample is used to estimate the population count for that particular subgroup. Each sample household is to represent other households in the entire population, and to indicate how many households are represented, a weight is used. In the case of the Homescan data, the “weights” that are used are the AC Nielsen projection factors.

Additionally, based on the above results obtained through the market by market census comparison, it can be inferred that these market areas are, for the most part, exhibiting differences from the population in a very similar fashion. Therefore, rather than specifying a separate model for each market area, each of the market areas in the data set will be all be included in the same model, while using the Chicago market area as the base market. Chicago is chosen as the base because it is the most represented market area in the data and also allows for direct interpretation of each of the four southeast US markets.

Table 4-1. Fresh seafood expenditures as a percent of total seafood expenditures by all panelists in all five market areas, 2008-2010.

	2008	2009	2010
Total Fresh Seafood Expenditures	$14,400	$18,828	$23,733
Total Seafood Expenditures	$71,798	$74,084	$89,653
Percent of Total	20.06%	25.41%	26.47%

Note: Expressed in real dollars (base=December 2010)

Table 4-2. Demographic comparison of seafood consuming households and non-seafood consuming households.

Variable	All households (n=2,557)	Seafood Eaters (n=1,961)	Non seafood eaters (n=596)
Education of Household Head (%):			
High school	0.94	0.94	0.96
College	0.24	0.23	0.27
Some college	0.55	0.54	0.58
Graduate School	0.07	0.07	0.08
Household Composition (%):			
Married	0.37	0.40	0.25
Female head only	0.37	0.36	0.39
Male head only	0.26	0.24	0.36
Presence of Children (%)	0.21	0.22	0.17
Annual Household Income (%):			
$0-$29,999	0.35	0.33	0.42
$30,000-$59,999	0.37	0.38	0.33
$60,000-$99,999	0.20	0.20	0.19
$100,000+	0.08	0.09	0.06
Income (1,000)	40.96	42.15	36.81
Race/Ethnicity (%):			
White	0.73	0.72	0.75
Black/African American	0.21	0.22	0.18
Asian	0.01	0.01	0.01
Hispanic	0.13	0.14	0.10
"Other" race	0.06	0.05	0.07
Age (% that is over 65)	0.42	0.40	0.50
Household size (number)	2.27	2.34	2.04
Occupation (% retired)	0.95	0.95	0.96
Market Area (%):			
Chicago	0.29	0.29	0.33
Miami	0.27	0.29	0.19
Houston	0.18	0.16	0.24
Memphis	0.09	0.09	0.09
New Orleans-Mobile	0.17	0.17	0.15

Note: All figures representing panelists utilize AC Nielsen household projection factors.

Table 4-3. Distribution of annual household income amongst the panel.

Income Category	Percent of Total	Midpoint (in thousands)
Under $5,000	1.84%	2.5
$5,000-$7,999	1.68%	6.5
$8,000-$9,999	1.84%	8.5
$10,000-$11,999	1.88%	10.5
$12,000-$14,999	4.38%	13
$15,000-$19,999	7.39%	17.5
$20,000-$24,999	8.02%	22.5
$25,000-$29,999	8.10%	27.5
$30,000-$34,999	8.10%	32.5
$35,000-$39,999	6.84%	37.5
$40,000-$44,999	5.71%	42.5
$45,000-$49,999	6.26%	47.5
$50,000-$59,999	9.66%	55
$60,000-$69,999	7.08%	65
$70,000-$99,999	12.83%	85
$100,000 & Over	8.41%	100

Note: All figures representing panelists utilize AC Nielsen household projection factors.

Table 4-4. Summary statistics of past purchase behavior and species/product form preference variables (n = 1,961 households).

Variable	Mean	Standard Deviation	Minimum	Maximum
FRESH (1 if panelist purchased fresh, over the counter seafood; 0 otherwise)	0.33	0.47	0	1
Average duration between purchases (weeks)	11.27	13.06	0	146
Number of seafood items purchased	13.18	17.89	1	205
Average weekly seafood expenditure ($)	$14.66	$29.79	$0.99	$1,044.61
Coupon use (1 if panelist used a coupon at least once, 0 otherwise)	0.20	0.40	0	1
Percent share of seafood expenditure dedicated to:				
Frozen fillet purchases	0.30	0.35	0.00	1.00
Breaded process form purchases	0.27	0.35	0.00	1.00
Generic/store brand purchases	0.32	0.36	0.00	1.00
Percent share of frozen seafood expenditure dedicated to:				
Shrimp	0.37	0.39	0.00	1.00
Salmon	0.09	0.23	0.00	1.00
Tilapia	0.10	0.23	0.00	1.00
Catfish	0.02	0.11	0.00	1.00
Cod	0.02	0.10	0.00	1.00

Table 4-5. Top ten average annual expenditures by species by all households, 2008-2010.

Species	Average Yearly Expenditure
RFCD fish shellfish	$19,373.57
Shrimp	$16,512.61
Salmon	$4,784.28
Tilapia	$4,223.61
Catfish	$1,132.66
Cod	$1,047.88
Scallop	$943.42
Crawfish	$874.92
Flounder	$852.10
Orange roughy	$673.92

Table 4-6. Census vs. Homescan comparison for Chicago market area.

Variable	2010 Census	Homescan Panelists (n=831)	Seafood consuming panelists (n=644)	Fresh seafood consuming panelists (n=229)
Age (percent of adult population 65 years or over)	13.9%	43.2%	41.7%	23.8%
Median annual household income	$47,408	$35,000-$39,999	$40,000-$44,999	$45,000-$49,999
Education (percent of adult population with a bachelor's degree)	33.6%	27.4%	27.9%	29.0%
Household composition (percent of married households)	32.7%	36.1%	40.6%	51.6%
Race (percent of adult population that is white)	45.0%	71.9%	71.0%	66.3%
Household size (mean number of persons)	2.57	2.25	2.33	2.61
Percent of households with children	25.2%	20.4%	20.6%	24.8%

Note: All figures representing panelists utilize AC Nielsen household projection factors.

Table 4-7. Census vs. Homescan comparison for Miami market area.

Variable	2010 Census	Homescan Panelists (n=662)	Seafood consuming panelists (n=532)	Fresh seafood consuming panelists (n=173)
Age (percent of adult population 65 years or over)	20.2%	45.4%	43.5%	27.4%
Median annual household income	$29,762	$30,000-$34,999	$30,000-$34,999	$35,000-$39,999
Education (percent of adult population with a bachelor's degree)	22.9%	25.5%	24.7%	36.2%
Household composition (percent of married households)	31.3%	38.0%	40.7%	44.7%
Race (percent of adult population that is white)	72.6%	81.5%	81.4%	82.9%
Household size (mean number of persons)	2.6	2.16	2.24	2.56
Percent of households with children	22.7%	17.0%	18.4%	31.7%

Note: All figures representing panelists utilize AC Nielsen household projection factors.

Table 4-8. Census vs. Homescan comparison for Houston market area.

Variable	2010 Census	Homescan Panelists (n=501)	Seafood consuming panelists (n=356)	Fresh seafood consuming panelists (n=89)
Age (percent of adult population 65 years or over)	12.7%	41.9%	39.1%	25.3%
Median annual household income	$44,648	$30,000-$34,999	$30,000-$34,999	$35,000-$39,999
Education (percent of adult population with a bachelor's degree)	28.7%	22.9%	22.3%	21.2%
Household composition (percent of married households)	39.0%	37.5%	42.0%	53.0%
Race (percent of adult population that is white)	50.5%	67.0%	67.4%	55.4%
Household size (mean number of persons)	2.69	2.52	2.63	3.18
Percent of households with children	30.2%	24.4%	24.5%	36.9%

Note: All figures representing panelists utilize AC Nielsen household projection factors.

Table 4-9. Census vs. Homescan comparison for Memphis market area.

Variable	2010 Census	Homescan Panelists (n=239)	Seafood consuming panelists (n=179)	Fresh seafood consuming panelists (n=56)
Age (percent of adult population 65 years or over)	14.6%	34.4%	29.7%	22.6%
Median annual household income	$36,817	$20,000-$24,999	$20,000-$24,999	$25,000-$29,999
Education (percent of adult population with a bachelor's degree)	23.4%	10.1%	9.4%	13.0%
Household composition (percent of married households)	29.7%	32.7%	34.3%	48.2%
Race (percent of adult population that is white)	29.4%	71.7%	72.2%	68.7%
Household size (mean number of persons)	2.59	2.16	2.26	2.62
Percent of households with children	27.8%	21.3%	27.0%	36.7%

Note: All figures representing panelists utilize AC Nielsen household projection factors.

Table 4-10. Census vs. Homescan comparison for New Orleans-Mobile market area.

Variable	2010 Census (New Orleans)	Homescan Panelists (n=324)	Seafood consuming panelists (n=250)	Fresh seafood consuming panelists (n=103)
Age (percent of adult population 65 years or over)	14.9%	37.6%	35.2%	26.4%
Median annual household income	$36,691	$25,000-$29,999	$25,000-$29,999	$25,000-$29,999
Education (percent of adult population with a bachelor's degree)	33.0%	24.0%	19.6%	24.5%
Household composition (percent of married households)	27.5%	36.6%	38.5%	39.5%
Race (percent of adult population that is white)	33.0%	66.1%	62.1%	62.4%
Household size (mean number of persons)	2.29	2.28	2.29	2.34
Percent of households with children	22.7%	22.8%	23.7%	22.3%

Note: All figures representing panelists utilize AC Nielsen household projection factors.

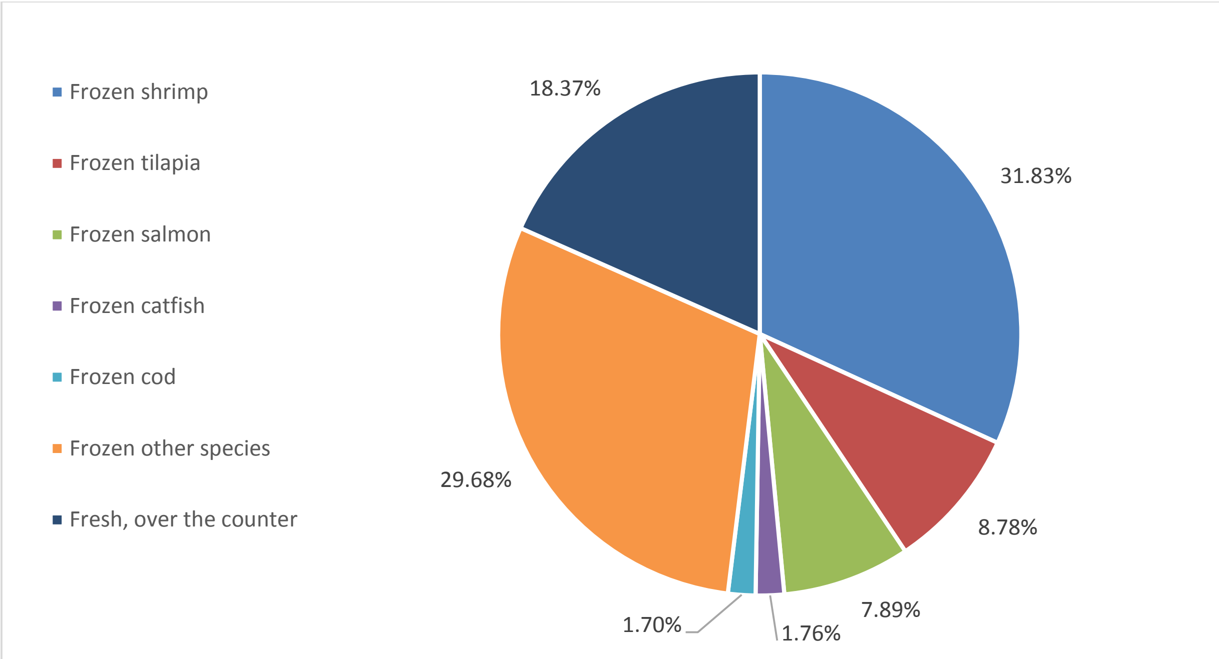

Figure 4-1. Average household allocation of seafood expenditures for fresh seafood and frozen seafood by species (n=1,961).

CHAPTER 5
MODEL SPECIFICATION

This analysis is concerned with predicting the probability of a household purchasing seafood and then predicting the probability of a seafood consuming household purchasing fresh, over the counter seafood. Therefore, for both of these models, the dependent variable will take the form of a Bernoulli distribution (only two viable outcomes). When considering the probability of purchasing seafood the outcome can either be “yes, the household purchased seafood” or “no, the household did not purchase seafood.” Similarly, when considering the probability of a household purchasing fresh, over the counter seafood, the outcome of the dependent variable can either be “yes, the household purchased fresh seafood” or “no, the household did not purchase fresh seafood.” Considering that probabilities are of interest here, teo probabilistic statistical classification model were specified.

Before modeling the probability of a seafood purchasing household purchasing fresh, over the counter seafood, the probability of a household in the panel purchasing seafood will be analyzed. As stated previously, 1,961 out of the 2,557 households (76.69%) in the data set purchased seafood at least once over the three year period that the data encompassed. The dependent variable for this first model (denoted as “SEAFOOD”) is a binary response variable coded as 1 if the household made at least one seafood purchase, and zero if the household did not purchase seafood. For this analysis, it is hypothesized that the probability of a household purchasing seafood is a function of household demographics:

$$Pr(SEAFOOD = 1) = f(D) \tag{5-1}$$

Where *D* is a vector of demographic variables. Equation 5-1 can be re-written as:

$$Pr(SEAFOOD = 1) = \alpha + \beta x + \varepsilon \qquad (5\text{-}2)$$

Where *x* is a vector of demographic variables, *β* is a vector of unobserved logistic regression parameters, *α* is a constant, and *ε* is an error term. The probability of a household purchasing seafood (denoted by π_S) can be re-written, and then simplified and linearized to form a viable logistic regression equation in the following fashion:

$$Pr(SEAFOOD = 1) = \pi_s = \frac{exp(\alpha+\beta x)}{1+exp(\alpha+\beta x)} \qquad (5\text{-}3)$$

Then, by taking the reciprocal of each side of Equation 5-3:

$$\frac{1}{\pi_s} = \frac{1}{\exp(\alpha+\beta x)} + 1 \qquad (5\text{-}4)$$

And then subtracting one from each side of Equation 5-4 yields:

$$\frac{1-\pi_s}{\pi_s} = \frac{1}{\exp(\alpha+\beta x)} \qquad (5\text{-}5)$$

When the reciprocal of each side is taken again, it yields:

$$\frac{\pi_s}{1-\pi_s} = \exp(\alpha + \beta x) \qquad (5\text{-}6)$$

Finally, by taking the natural logarithm of each side of Equation 5-6, the logit transformation is complete:

$$\textit{Logged odds of SEAFOOD} = ln\left(\frac{\pi_s}{1-\pi_s}\right) = \textit{Logit(SEAFOOD)} = \alpha + \beta x + \varepsilon \qquad (5\text{-}7)$$

Equation 5-7 is now linearized on the right side of the equation and represents the logistic regression model that will be used to predict the probability of household purchasing seafood. The results from this model are illustrated in Table 6-1.

Similarly, a maximum likelihood model with for a binary dependent variable ad assuming the logit link function was be constructed to model the probability of a seafood eating household purchasing fresh, over the counter seafood products. The analysis is again conducted at the household level, however since this model is only concerned with seafood purchasing households, the number of observations used is 1,961. The reason why only seafood purchasing households are investigated when predicting the probability of a household purchasing fresh, over the counter seafood is because this allows for purchase behavior and species/product form preferences to enter the model. Since 596 households in the data set did not purchase seafood, they would be represented as missing values in the model because there is no purchase information associated with the household. Therefore, these 596 households that did not purchase seafood at all over the three years are excluded from the second model.

It is hypothesized that the probability of purchasing fresh, over the counter seafood for a seafood purchasing household is a function of demographics, past purchase behavior, and species/product form preferences. This can be represented by the following general equation:

$$Pr(FRESH = 1) = f(D,B,S) \tag{5-8}$$

Where "FRESH" is a binary response variable coded as 1 if the household made at least one fresh, over the counter seafood purchase over the three year period, and 0 if not, *D* is a vector of demographic variables as before, *B* is a vector of past purchase behavior variables, and *S* is a vector of species/product form preference variables. Equation 5-8 can be re-written as:

$$Pr(FRESH = 1) = \pi_F = \alpha + \delta_1 D + \delta_2 B + \delta_3 S + \varepsilon \tag{5-9}$$

Where α is a constant, ε is an error term, and δ_1, δ_2, and δ_3 are vectors of unobserved logistic regression parameters corresponding to demographics, past purchase behavior, and species/product form preferences respectively. Using the same approach that is used in Equations 5-3 through 5-6, the following logit equation was obtained:

$$\textit{Logged odds of FRESH} = ln\left(\frac{\pi_F}{1-\pi_F}\right) = \textit{Logit(FRESH)} = \alpha + \delta_1 D + \delta_2 B + \delta_3 S + \varepsilon \quad (5\text{-}10)$$

Equation 5-10 is now linearized on the right side of the equation and represents the logistic regression model that will be used to predict the probability of a seafood purchasing household purchasing fresh, over the counter seafood products. The results from this model are illustrated in Table 6-2.

CHAPTER 6
EMPIRICAL RESULTS

The LOGIT procedure in SAS was first used to estimate model parameters, and AC Nielsen projection factors were used to properly weight each household. However, using the WEIGHT statement in a LOGIT procedure in SAS can distort standard error estimates, which can lead to invalid conclusions. To alleviate this problem, the SURVEYLOGIT procedure in SAS was used, because using the WEIGHT statement in this procedure does not distort standard error estimates. The following results of this analysis reflect the results of the SURVEYLOGIT procedure.

Many of the demographic variables had to be coded as dummy variables to remain quantitative in nature. Therefore, base categories for these dummy variables had to be established. For household composition, the base category is married (co-headed) households. For race, the base category is white households. For market area, the base category is Chicago households (Chicago is the most represented market area in the panel, and is the only market area outside the southeastern United States). For the presence of children, the base category is households that do not have any children under eighteen years of age. For age, the base category is households in which the head is under 65 years of age. For education, the base category is households in which the head has not completed college. For household income, the midpoint of each income category was calculated and used in the models; this follows previous literature (Martinez 2007) that utilized Homescan data and a logit model (Martinez 2007). This income coding technique also provides for ease of interpretation since the income effects can be interpreted as, “a one thousand dollar increase in annual household income leads to some incremental probability increase/decrease in the probability of a dependent variable occurring." Finally, household size was coded as a continuous variable.

Model 1: Predicting the Probability of Household Purchasing Seafood

Equation 5-7 was used to predict the probability of a household in the panel purchasing seafood (model 1). Households headed by just a female or just a male had statistically significant negative parameter estimates; this implies that married (co-headed) households are more likely to purchase seafood when compared to single headed homes. Annual household income had a statistically significant positive parameter estimate, implying that as income increases, the likelihood of purchasing seafood increases as well. Age and education had statistically significant negative parameter estimates, which implies that households with older heads are less likely to purchase seafood and that households with more educated heads are less likely to purchase seafood. As it pertains to market area, Miami households are statistically significantly more likely to purchase seafood than their Chicago household counterparts.

Model 2: Predicting the Probability of a Household Purchasing Fresh Seafood

Equation 5-10 was used to predict the probability of a seafood-purchasing household purchasing fresh, over the counter seafood products (model 2). Households headed by just a female are statistically significantly less likely to purchase fresh, over the counter seafood than married (co-headed) households. Additionally, the parameter estimate for age is statistically significant and negative (similar to model 1), implying that older households are less likely to purchase fresh, over the counter seafood products. When examining market area, households in Miami and New Orleans-Mobile are statistically significantly less likely to purchase fresh, over the counter seafood than were panelists in Chicago. The behavioral variables and species/product form preference variables that were entered into the model for model 2 are all statistically significant except for percent share of frozen seafood expenditure dedicated to cod and dedicated to catfish. As a household's number of seafood items purchased increases, so does the likelihood of a household purchasing fresh, over the counter seafood. Additionally, if a household used a coupon at least once on a seafood purchase, they are statistically significantly more likely to purchase fresh, over the counter seafood products as well. Increases in all of the following variables lead to a decrease in the likelihood of a household purchasing fresh, over the counter seafood products: average weekly seafood expenditure, average duration between purchases, the percent share of seafood expenditure dedicated to generic/store brand purchases, frozen fillet purchases, and breaded process form purchases, and the percent share of frozen seafood expenditure dedicated to frozen shrimp, tilapia, and salmon.

To further examine the relationship between some of the statistically significant purchase behavior variables and the probability of a household purchasing fresh, over the counter seafood products, effect plots were used. These effect plots were generated in SAS to explain the relationship between an independent variable and its effect on the predicted probability of a household purchasing fresh, over the counter seafood while holding all other independent variables in the models constant at their mean values. When examining the effect plot for "average duration between purchases" (Figure 6-1), it is evident that as the average duration between purchases for a household increases, a household's likelihood of purchasing fresh, over the counter seafood decreased. Therefore, those households who purchase seafood more frequently are more likely to purchase fresh, over the counter seafood products. When examining the effect plot for “percent share of seafood expenditure dedicated to breaded process form purchases,” (Figure 6-2) as a household increased the share of their seafood budget allocated to breaded seafood, they were less likely to make the choice to go to the fresh counter at the grocery store and purchase fresh seafood. Additionally, when looking at the effect plot for “number seafood items purchased” (Figure 6-3), as a household purchases more seafood items in general, they were more likely to go to the fresh counter at the grocery store and purchase fresh seafood products. This coincides with the effect plot for “average duration between purchases” (Figure 6-1) in some respects because both reflect the fact that households that purchase seafood more often are more likely to purchase fresh, over the counter seafood products.

Odds Ratios

The logit parameter estimates in the previous discussion have little direct meaning, however they are used to calculate the incremental probability increase/decrease that an independent variable leads to as it pertains to the probability of a dependent variable occurring. Direct interpretation of the independent variables can be obtained through the calculation of odds ratios based on the parameter estimates of the independent variables in question. For example, in Table 6-2, the odds ratio estimate for “number of seafood items purchased” is 1.041. This can be interpreted as, “if a seafood purchasing household makes one additional seafood purchase, they are 1.041 times more likely to purchase fresh, over the counter seafood products” (their probability of purchasing fresh, over the counter seafood increases by 4.1%). Graphical representations of these odds ratio estimates are depicted in Figure 6-4 and in Figure 6-5 (corresponding to model 1 and model 2, respectively).

Referring to Figure 6-4, the variable “Miami” has the largest probability effect (in terms of absolute value). This shows that panelists in Miami are 73.3% more likely to purchase seafood than were panelists in Chicago. The only other positive and statistically significant odds ratio in Model 1 is “annual household income.” As household income increased by $1,000, a household was 0.6% more likely to purchase seafood. When household composition is examined, female only headed households and male headed only households were statistically significantly less likely to purchase seafood than were married or “co-headed” households. Female only headed households were 30.1% less likely to purchase seafood than married households and male only headed households were 50.0% less likely to purchase seafood than were married households. When considering age, households in which the head was 65 years or older were 33.5% less likely to purchase seafood than were households in which the head was under 65 years of age. The outcome of the “education” independent variable was surprising; considering that income had a statistically significant positive relationship with the probability of a household purchasing seafood, and that income and education tend to be positively correlated, it came as a surprise that households in which the head had completed college were 35.5% less likely to purchase seafood than were households in which the head did not complete college.

Referring to Figure 6-5, the “percent share” variables corresponding the percent share of a household’s seafood budget that was allocated toward shrimp, tilapia, and salmon all had very large probability effects (in terms of absolute value). This means that as a household increases the share of their frozen seafood budget on these particular species of seafood (at the margin), they were statistically significantly less likely to purchase fresh, over the counter seafood products. Additionally, as a household spent more on breaded seafood products and frozen filleted seafood products (at the margin), they were statistically significantly less likely to purchase fresh over the counter seafood. This implies that as households spent more on processed seafood, they were less likely to make the choice to go to the counter at the grocery store and purchase fresh seafood. When examining the purchase behavior of the households, as a household spent one extra dollar, on average, on seafood in a week in which they purchase seafood, they were 3.2% less likely to purchase fresh, over the counter seafood. Therefore, as a household spends more money on seafood in general, they were statistically significantly less likely to make the choice to go to the counter and buy fresh seafood, which is surprising considering that fresh seafood products have been considered luxury goods. Adding to this, households that purchase seafood more frequently were statistically significantly more likely to purchase fresh, over the counter seafood as well. As a household's average duration between seafood purchases increased by one week, they were 4.2% less likely to purchase fresh, over the counter seafood and as a household's number of seafood items purchased increased at the margin, they were 4.1% more likely to purchase fresh, over the counter seafood. Due to these findings, marketers and distributors of fresh seafood should target areas in which consumers tend to buy more seafood in general and buy seafood more frequently when compared to other possible markets for fresh seafood products.

The use of coupons plays a large role in predicting the probability of a household purchasing fresh, over the counter seafood. Households that used coupons on seafood (fresh or frozen) were 118.3% more likely to purchase fresh, over the counter seafood.

Therefore, the use of coupons is a very strong predictor in trying to model the likelihood of a household purchasing fresh, over the counter seafood products. Additionally, as a household increased their share of generic/store brand purchases by 1%, they were 86.6% less likely to purchase fresh, over the counter seafood.

When examining the demographic effects in Model 2, four variables are statistically significant and negative. Households in which the head is 65 years or older are 60.3% less likely to purchase fresh, over the counter seafood than were households in which the head is under 65 years of age. Also, female only headed households are 47.9% less likely to purchase fresh, over the counter seafood than were married households. And finally, Miami households are 43.8% less likely and New Orleans-Mobile households are 45.9% less likely to purchase fresh, over the counter seafood than were households in Chicago.

Table 6-1. Model 1: Predicting the probability of a household purchasing seafood (n = 2,557 households).

Variable	Mean	Parameter Estimate	Odds Ratio
SEAFOOD (1 if yes)	0.77	Dependent	Variable
Education (1 if completed college)	0.24	-0.438**	0.645
Female head only	0.37	-0.359*	0.699
Male head only	0.26	-0.693***	0.500
Income (thousands)	40.96	0.006**	1.006
Age (1 if over 65)	0.42	-0.407***	0.665
Household size	2.27	0.079	1.082
Presence of children (1 if yes)	0.21	-0.206	0.814
Black/African American (1 if yes)	0.21	0.226	1.253
Asian (1 if yes)	0.01	0.224	1.251
"Other" race (1 if yes)	0.06	-0.488	0.614
Hispanic (1 if yes)	0.13	0.429	1.535
Miami (1 if yes)	0.27	0.550***	1.733
Houston (1 if yes)	0.18	- 0.286	0.751
Memphis (1 if yes)	0.09	0.180	1.197
New Orleans-Mobile (1 if yes)	0.17	0.291	1.338

Note: *significant at 10% level, **significant at 5% level, ***significant at 1% level

Table 6-2. Model 2: Predicting the probability of a household purchasing fresh, over the counter seafood (n = 1,961 households).

Variable	Mean	Parameter Estimate	Odds Ratio
FRESH (1 if yes)	0.33	Dependent	Variable
Education (1 if completed college)	0.23	0.107	1.112
Female head only	0.36	-0.651**	0.521
Male head only	0.24	-0.225	0.799
Income (thousands)	42.15	-0.005	0.995
Age (1 if over 65)	0.40	-0.924***	0.397
Household size	2.34	0.031	1.031
Presence of children (1 if yes)	0.22	0.280	1.323
Black/African American (1 if yes)	0.22	0.105	1.111
Asian (1 if yes)	0.01	-0.760	0.468
"Other" race (1 if yes)	0.05	-0.512	0.599
Hispanic (1 if yes)	0.14	-0.041	0.960
Miami (1 if yes)	0.29	-0.577**	0.562
Houston (1 if yes)	0.16	-0.431	0.650
Memphis (1 if yes)	0.09	-0.022	0.978
New Orleans-Mobile (1 if yes)	0.17	-0.615**	0.541
Average duration between purchases (weeks)	11.27	-0.043***	0.958
Average weekly seafood expenditure (dollars)	14.66	-0.033***	0.968
Number of seafood items purchased	13.18	0.041***	1.041
Coupon use (1 if yes)	0.20	0.781***	2.183
Percent share of seafood expenditure dedicated to:			
Generic/store brand purchases	0.32	-2.012***	0.134
Frozen fillet purchases	0.30	-2.646***	0.071
Breaded process form purchases	0.27	-4.657***	0.009
Percent share of frozen seafood expenditure dedicated to:			
Shrimp	0.37	-1.526***	0.217
Salmon	0.09	-2.252***	0.105
Tilapia	0.10	-2.017***	0.133
Catfish	0.02	-1.114	0.328
Cod	0.02	-0.745	0.475

Note: *=significant at 10% level, **=significant at 5% level, ***=significant at 1% level

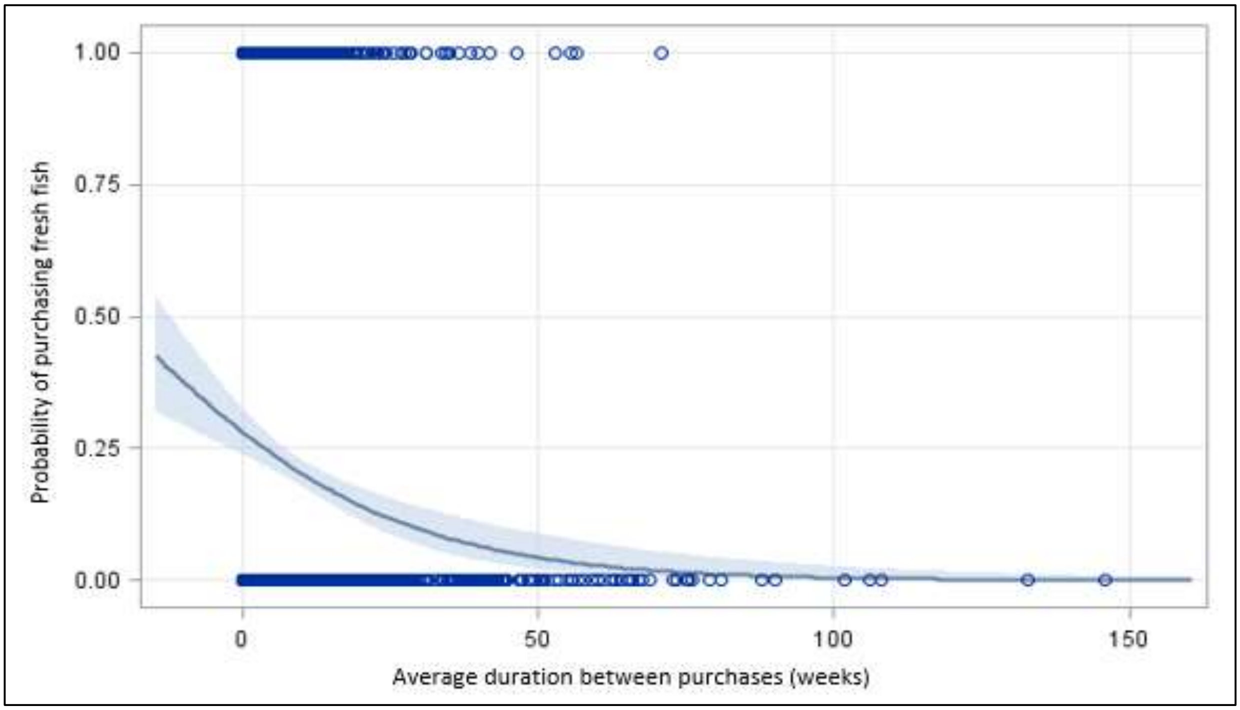

Figure 6-1. Effect plot for average duration between purchases.

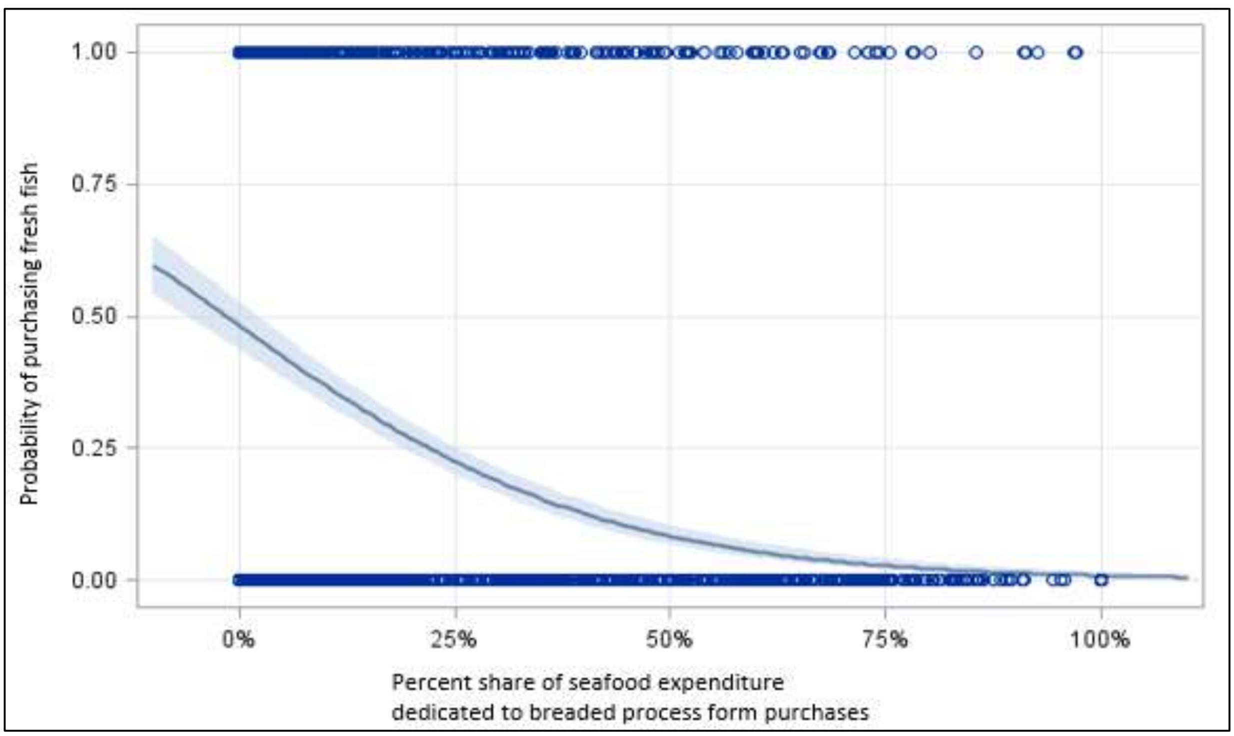

Figure 6-2. Effect plot for percent share of seafood expenditure dedicated to breaded process form purchases.

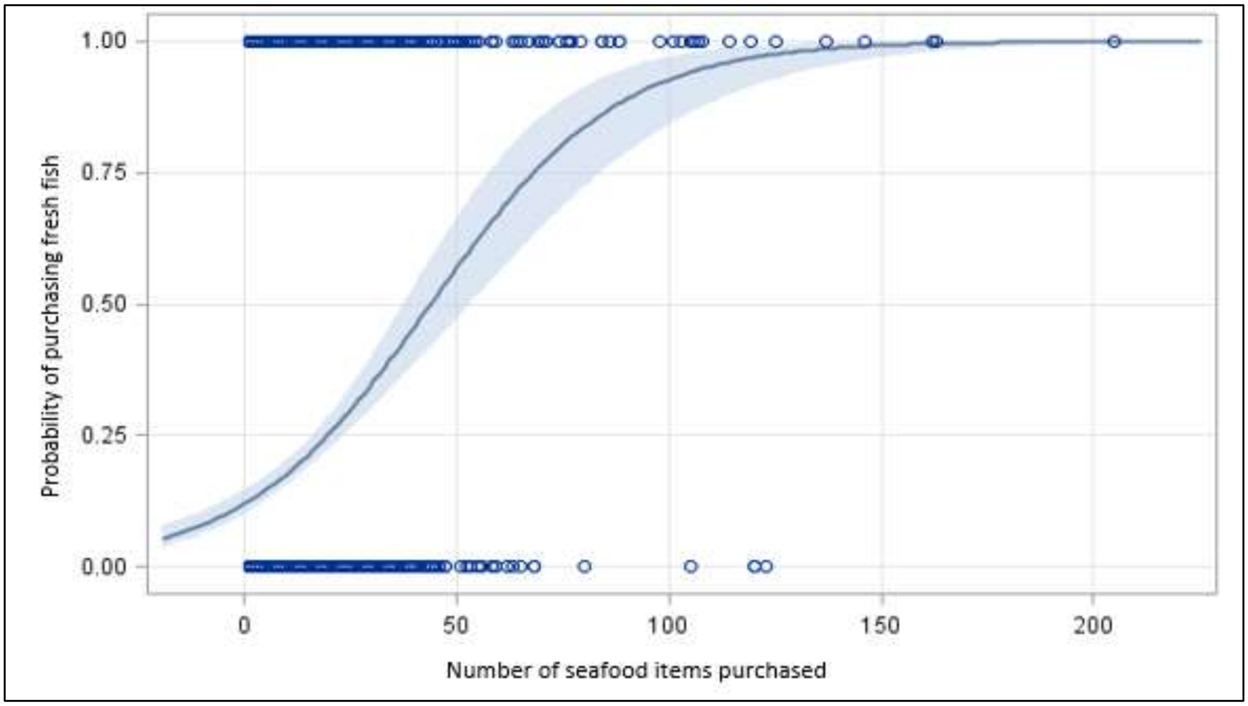

Figure 6-3. Effect plot for number of seafood items purchased.

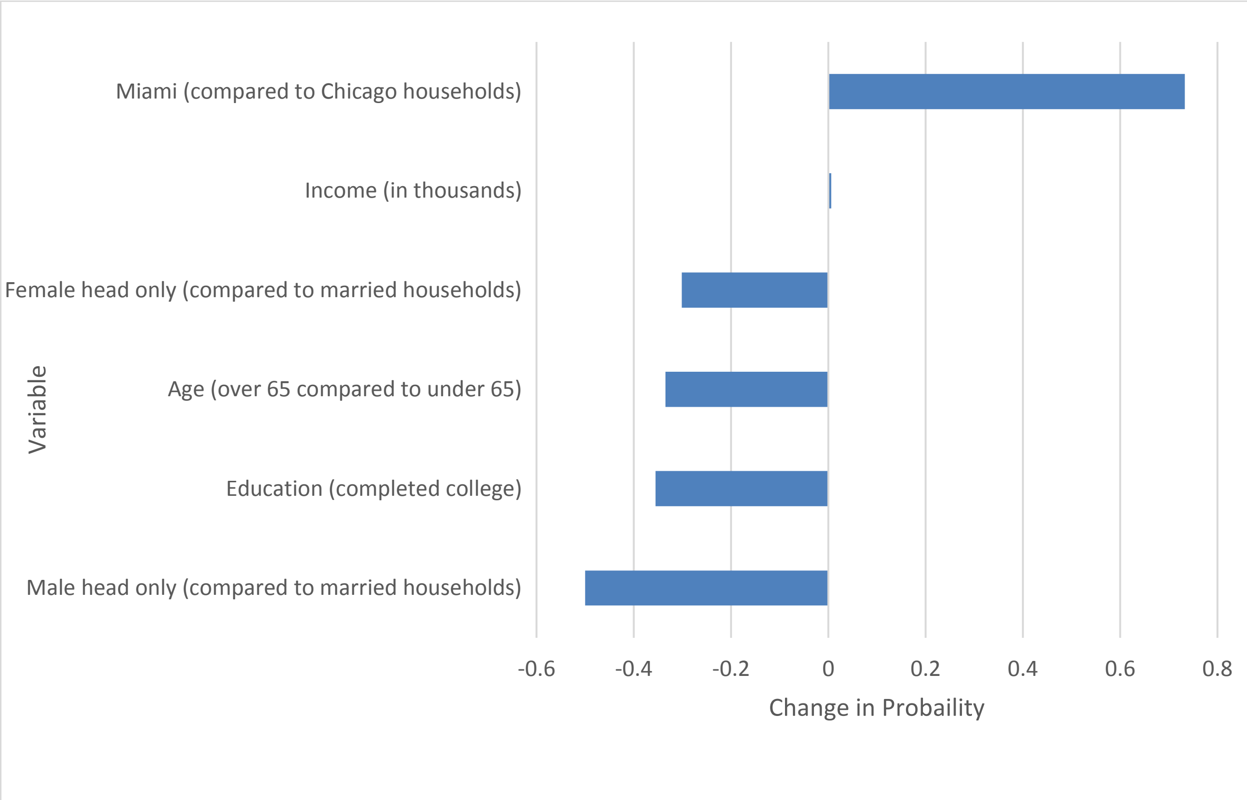

Figure 6-4. Change in probabilities of purchasing seafood based on statistically significant predictor variables in model 1.

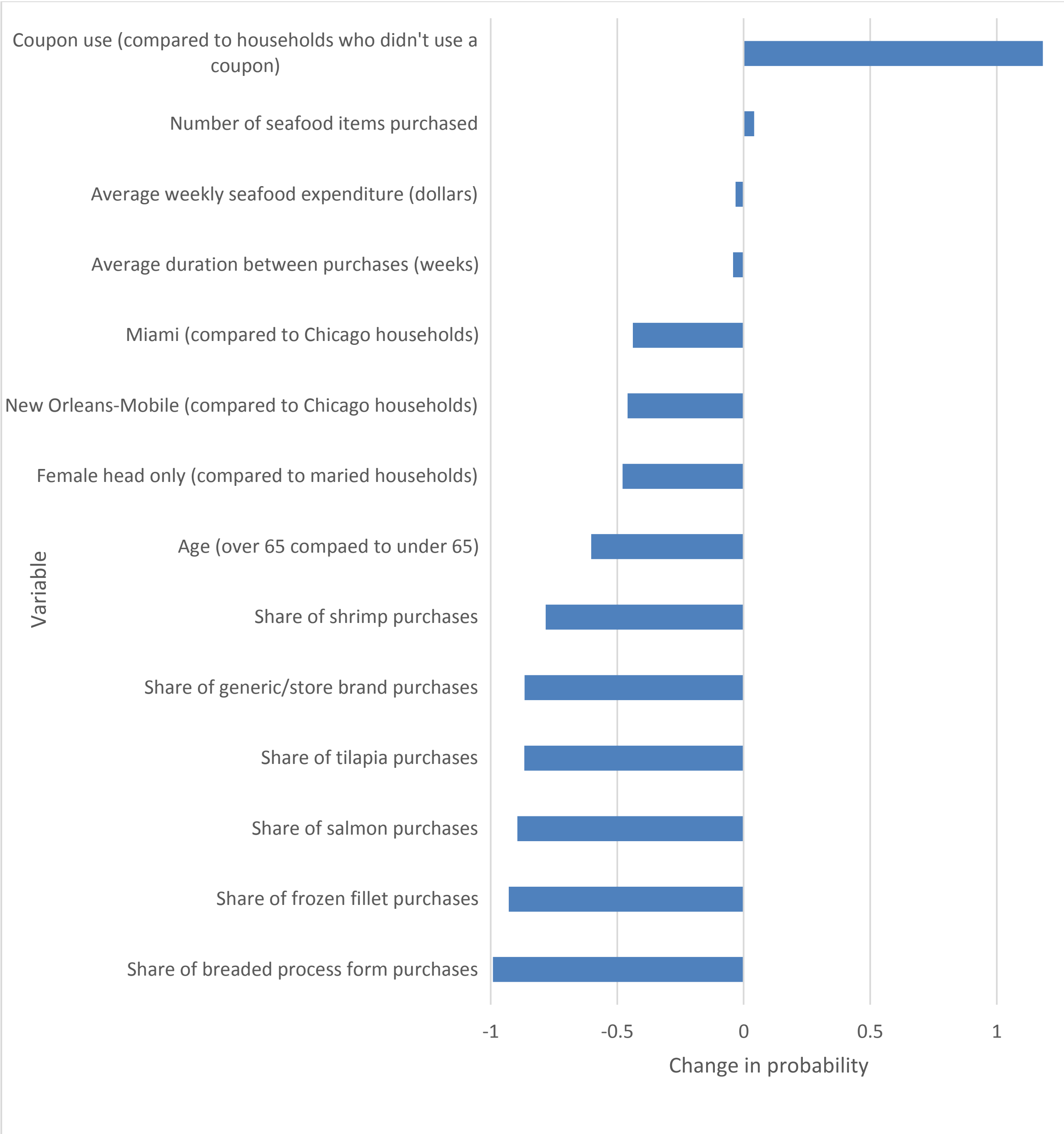

Figure 6-5. Change in probabilities of purchasing fresh, over the counter seafood based on statistically significant predictor variables in model 2.

CHAPTER 7
CONCLUSIONS

Overview of Project

The goal of this analysis was to correlate the probability of a household purchasing seafood with household demographics, and from there, to correalte the probability of a seafood consuming household purchasing fresh, over the counter seafood products with household demographics, household purchase behavior, and household species/product for preferences. To that end, weekly AC Neilson Homescan data covering a three-year period was utilized to model these choices based on utility maximization theory and accounting for dichotomous response variables. In addition to the modeling results, the U.S. Census data were compared with the characteristics of the Homescan panelists (both those that purchased seafood and those that did not) for each of five major U.S. market areas. Finally, results are compared and discussed in relation to results from previous studies.

Discussion and Implications of Results

Results from this analysis suggest that seafood consuming households are demographically different from households that do not consume seafood. Households that were more likely to purchase seafood tend to be wealthier (perhaps indicating the luxury nature of seafood products) and have younger household heads. However, households in which the head completed college were overall less likely to purchase seafood. This is perhaps a possible indication of a growing shift away from seafood consumption amongst more educated consumers due to negative perceptions of overseas seafood farming, concerns for the health of wild stocks, and environmental impacts of the 2010 Deepwater Horizon Gulf Oil Spill.

Moreover, there are some key differences among seafood consuming households as it pertains to the consumption of fresh, over the counter seafood products. As stated previously, households with older heads were less likely to purchase fresh, over the counter seafood, as were female only headed households when compared to married households. Households in Miami and New Orleans-Mobile households were less likely to purchase fresh, over the counter seafood as well (when compared to households in Chicago). Coinciding with previous literature, households who purchase more seafood (higher number of seafood items purchased) and more frequently (smaller average duration between purchases) were more likely to purchase fresh, over the counter seafood (Nauman et al. 1995). Additionally, households that devoted more time to using coupons for seafood were more likely to choose to buy fresh seafood from the counter. Also as expected, as a household devoted more of their seafood budget toward frozen shrimp, tilapia, or salmon, their likelihood of purchasing fresh, over the counter seafood declined. Similarly, as a household purchased more frozen filleted, breaded, or generic/store-branded seafood products, they were less likely to choose to go to the counter for fresh fish and seafood. Households with higher average weekly seafood expenditure values were also less likely to purchase fresh, over the counter seafood, which came as a surprise.

These key demographic, behavioral, and preferential differences amongst households that did/did not purchase fresh, over the counter seafood allow for firms and marketers to better segment the market for fresh seafood and create more opportunities in relatively advantageous markets for their products. By analyzing the statistically significant factors related to the likelihood of purchasing fresh, over the counter seafood and having a demographic profile of a market in question, emerging and future demand can be investigated and calculated.

Recommendations to Firms and Marketers

Results from this analysis have several implications for firms involved in the production of seafood, marketers of seafood products, and other vested interests throughout the supply chain of seafood production. Targeting areas in which the population has a high proportion of married households would be relatively advantageous for seafood sales, because model 1 showed that that single headed households are statistically significantly less likely to purchase seafood than are married households. Additionally, areas in which the population tends to be older in age would not be a wise target market for seafood producers and seafood marketers because model 1 suggests that households in which the head is 65 years or older are statistically significantly less likely to purchase seafood. Moreover, targeting high income areas is wise because as income increase, so too does the likelihood of purchasing seafood. One of the surprising findings from model 1 was that college educated households were less likely to purchase seafood, leading to the conclusion that more educated market areas would not be the wisest choice when trying to market/sell seafood products effectively; perhaps because they have heard more about the environmental concerns associated with fishing wild stocks in the ocean or culturing seafood near shore. Also as far as region is concerned, Miami households are statistically significantly more likely to purchase seafood than are Chicago households.

Model 2 (the likelihood of a seafood consuming household purchasing fresh, over the counter seafood products) revealed that markets with a high proportion of older residents would not be an advantageous place for the sale/marketing of fresh, over the counter seafood products. Additionally, Miami households are statistically significantly less likely than Chicago households to purchase fresh, over the counter seafood, and the same is true for households in New Orleans-Mobile. Purchase behaviors and species/product form preferences explained a lot regarding the likelihood of a household purchasing fresh, over the counter seafood products. For example, coupon using households were statistically significantly more likely to purchase fresh seafood when compared to households who do not utilize coupons; as such to increase purchases of fresh seafood, it would be wise to introduce coupons for seafood in general into a market. Also as expected, those who purchase more seafood in general and those who purchase seafood more frequently are more likely to purchase fresh seafood products; therefore if consumers in a particular area exhibit characteristics of frequent and numerous seafood purchases, these consumers would be a wise target for producers of fresh seafood products. Market research can also be completed to identify areas with consumers who purchase a large share of seafood products that have undergone some form processing (filleting, breading, etc.); these consumers are less likely to purchase fresh, over the counter seafood products and it would be more effective for producers and marketers of fresh seafood products to avoid markets in which these type of consumers are prevalent.

Further Research

The analysis in this project can be extended in several ways. First, there is the possibility of an alternative estimation procedure, such as a two stage estimation approach (i.e. the double hurdle model). The motivation underlying the hurdle formulations is that a binomial probability model governs the binary outcome of whether a count variable has a zero or a positive realization. If the realization is positive, the “hurdle is crossed”, and the conditional distribution of the positives is governed by a truncated-at-zero count data model (Mullahy 1986). As a result, there could be some efficiency gains by modeling both household decisions simultaneously.

The characteristics of the AC Nielsen Homescan panel also should be considered in more detail. In terms of the time horizon, the data encompass a time period that includes purchases from before and after the 2010 Gulf Deepwater Horizon Oil Spill. This has several implications such as the possible decline in fresh, over the counter seafood products (especially in the southeastern United States) after the oil spill and to the effect of negative perceptions concerning the dangers of consuming contaminated or “dirty” seafood from the Gulf of Mexico. Also, the treatment of households that may have spent shorter or longer times in the panel could also affect the results that relate to many of the variables (since AC Nielson aims for a balanced panel, this would only be an issue with households at the beginning and end of the time series covered). In terms of representativeness, there are some stark differences between the panel and the Census profiles of the market areas in the data set (Tables 4-6 through 4-10). The panel was overwhelmingly retired and older, leading to the conclusion that those who volunteer to participate in the Homescan panel tend to have more extra time on their hands to complete the task of scanning every purchase when they get home from the grocery store. Additionally, it seems as if minorities are harder to reach for participation in the Homescan panel because their share is less in the sample than as reported by the Census. That said, the projection factors (post stratification weights) associated with each household in the panel are calculated precisely to correct for any over/under sampling of a particular population subgroup; as such, the characteristics of the sample are adequate for modeling the choices examined in this paper.

Finally, since the data contain information on price and quantity, demand functions can be estimated using the Almost Ideal Demand System model. Using this method, the price fluctuations of seafood products and subsequent consumer responses can be used to calculate own price, cross price, and income elasticities. The data set is very rich in information and analysis can go in several directions. Investigation into the nature of the market for fresh, over the counter seafood products is an exciting and under-researched topic, and there is more work that can be done outside the scope of this analysis, particularly within each market and for particualr species.

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BIOGRAPHICAL SKETCH

Matthew Gorstein earned his Bachelor of Science in economics from University of Florida's Warrington College of Business Administration in the spring of 2013. He obtained his Master of Science in food and resource economics from University of Florida's College of Agricultural and Life Sciences in the fall of 2014. Besides devoting time to coursework, Matthew worked as a graduate research assistant for the Department of Food and Resource Economics and as a sales/service associate at a local furniture store. He was also involved in his department's chapter of the Graduate Student Organization, serving as Vice President of Communications for the 2014 calendar year.

Matthew was awarded the Aylesworth Scholarship from the Aylesworth Foundation for the Advancement of Marine Science in February of 2014 for his research into the demand for fresh seafood products. His research has been presented at conferences and workshops such as the International Institute of Fisheries Economics and Trade in July 2014 and the Gulf State Marine Fisheries Commission Fisheries Economics Workshop in March 2014.